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COST FINDING

IN

Woolen and Worsted Mills

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"Straight Line" Textile Calculations

Cost Finding in Woolen and Worsted Mills

By

SAMUEL S. DALE

UNIV. OF CALIFORNIA

PUBLISHED BY

TEXTILES

BOSTON, MASS.

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Introduction

From a business standpoint it is of vital importance for every manufacturer to know the cost of each fabric made in his mill. Without such knowledge the business of manufacturing becomes guesswork and the manufacturer may find too late that his goods have been sold at a loss because of too low an estimate of cost or that they have not been sold at all because the price was fixed above the market as a result of the cost estimate being too high.

The diversity in textile fabrics is so great and the conditions of manufacture vary so widely in different mills that it is impossible to give general directions for cost finding that would suit every case. All of the operations of converting raw material into the finished product may be carried on in one mill. Frequently, however, the material is taken in a partially manufactured condition from one mill to another, where the work is advanced or completed. Some parts of a fabric may be made from the raw stock in one mill, while other parts of the same fabric may have been made in several mills.

Cost of Raw Material

The calculation of the cost of raw material in yarn or cloth is a comparatively simple operation. To make this calculation it is necessary to know the original cost of the stock as received at the mill, together with the shrinkage in manufacturing and the value of waste products.

The value of the waste products is sometimes omitted from the calculations, with the object of having the omission of this factor, which reduces the cost, compensate for possible errors in other items; in other words, that the estimate may be on the "safe side." The value of the waste products is too large in some cases (worsted yarn, for example) to be omitted and it is preferable to allow for it in all cases.

The most elusive factor in calculating the cost of raw material is the shrinkage in manufacturing. This varies with different grades of stock and can be determined only by careful tests of large quantities of material passing through the mill. A system of reports should be established to show the quantity of finished material obtained from lots of stock delivered to different departments.

Take a worsted mill for example. Each lot of wool as it is purchased should be numbered and known by this number in the mill. Sorting, scouring, combing and spinning tests of each purchase should be made on a scale sufficiently large to give reliable results.

Cost of Sorted Wool

The sorting test will show the quantity of each sort obtained from the wool, and a comparison of the test with those of previous lots will show whether the wool is yielding better or poorer results. This sorting test should be made on as large a scale as convenient. A record of the weight of each sort is made and the value of the side sorts (that is, all except the body sorts) is estimated and deducted from the total cost of the lot, the remainder representing the cost of the body sort. The cost of the latter per pound is then readily calculated. The following example will illustrate the operation:

Ex. A lot of 10,618 pounds of Australian 3/8 blood crossbred wool cost $2,276.50, or 21 44/100 cents per pound, delivered at the mill. When sorted there were besides the 3/8 body sort, burry valued at 12 cents, fribs at 12 cents, cotted wool at 12 cents and 1/4 blood wool at 20 cents per pound. The following statement gives the quality of each sort and method of calculating the cost of the 3/8 body sort:

10,618 pounds	21 44/100 cts.		$2,276.50
Side sorts:			
Burry, 70 lbs.	12 cts.	$8.40	
Fribs, 32 lbs.	12 cts.	3.84	
Cotted wool, 5 lbs.	12 cts.	.60	
1/4 blood wool, 200 lbs.	20 cts.	40.00	52.84
3/8 blood body sort, 10,311 lbs.		$0.2157	$2,223.66

The cost of the body sort per pound, $.2157, is found by dividing the total cost, $2,223.66, by the number of pounds, 10,311.

Cost of Wool in Worsted Top

The combing test is the best method for indicating the manufacturing value of the wool. The principle on which the test is made is the same as that of the sorting test. A large lot of the body sort is kept separate during the scouring, carding and combing processes. The waste and combed top from the lot are carefully weighed. The value of the waste products is estimated and deducted from the original cost of the lot. The remainder represents the cost of the wool in the combed top, from which the cost per pound is obtained by dividing by the number of pounds of top.

The following illustration will show the method of calculation:

Ex. Ten thousand pounds of the 3/8 body sort of the Australian wool referred to in the preceding example was tested to determine the cost of the combed top. The following statement shows the quantity of by-products and top, also the valuation of the by-products and raw stock, and the cost of the top:

10,000 pounds (grease weight) 3/8 blood Australian 21 57/100 c.			$2,157.00
By-products:			
11.4 per ct. noil, 757 lbs.	16 cts.	$121.12	
2.5 per ct. card waste, 166 lbs.	10 cts.	16.60	
.2 per ct. bur waste, 13 lbs.	1 ct.	.13	
.9 per ct. lap waste, 61 lbs.	20 cts.	12.20	150.05
85 per cent. top, 5,655 lbs.	35 1/2 c.		$2,006.95
100 per cent. clean weight, 6,652 lbs.			

Loss in scouring, 33 1/2 per cent.

Such tests show the value of the particular lot tested and also enable a comparison to be made between the cost of the products obtained from different kinds of materials. By this comparison the stock

yielding the best results in manufacturing is disclosed. This is illustrated by the above test of Australian crossbred, which was made to determine whether this kind of wool was more profitable than the 3/8 unwashed Virginia, which had been used for years in the same mill. The tests of the Virginia wool resulted as follows:

Sorting Test:

77 bags, 12,938 lbs.	20 cents		$2,587.60
Burry, 359 lbs.	12 cents	$43.08	
Stained, 70 lbs.	12 cents	8.40	
Seedy, 7 lbs.	12 cents	.84	
Clips, 53 lbs.	1 1/4 cents	.66	
Strings, 74 lbs.	1/2 cents	.37	
1/4 blood, 830 lbs.	12 cents	99.60	
Low wool, 67 lbs.	10 cents	6.70	159.65
Invisible loss, 10 lbs.			
3/8 blood body sort, 11,468 lbs.		$.2111	$2,427.95

Combing Test:

11,468 lbs. (grease weight)	21.17 cents	$2,427.95

By-products:

11.6 p. c. noil	709 lbs.	16 c.	$113.44	
2.9 p. c. card waste	174 lbs.	10 c.	17.40	
.4 p. c. bur waste	26 lbs.	1 c.	.26	
.6 p. c. lap waste	34 lbs.	20 c.	6.80	137.90
84 1/2 per cent. top	5140 lbs.	44 1/2 c.		$2,290.05

100 per cent. clean weight, 6083 lbs.

Loss in scouring, 47 per cent.

A comparison of these two tests shows that the Australian top costs 9 cents per pound less than the Virginia top. What this difference meant may be more clearly realized when we consider that the mill in question operated seven combs, which produced about 2,000 pounds of top per day. The difference of 9 cents per pound would amount to $180 per day

or $54,000 per year. This expensive Virginia wool had been used exclusively for twenty years in this particular mill for this grade of top, the judgment of the wool buyer having been accepted as conclusive as to the value of the wool during that time.

This case illustrates the importance of accuracy in mill tests to determine the waste and cost of the material in process. Practically the same proportion of top was obtained from the clean wool of each grade, the difference in the cost of the top being due to the difference in loss in scouring, which was 33 1/2 per cent. for the Australian wool and 47 per cent. for the Virginia. The Australian wool served the purpose better than the Virginia, being longer, stronger, equal in quality and containing less impurities. The lots tested were bought about the same time and at prevailing market rates.

Cost of Wool in Worsted Yarn

The calculation of the raw material cost of yarn is based on the same general principle as for top. If the cost of worsted yarn is to be calculated, a test is made with a large lot of worsted top. The following illustration will make the calculation clear without further explanation:

The 5,655 pounds of Australian top above referred to yielded when spun 280 pounds of waste worth 20 cents per pound and 5,090 pounds of yarn, showing an invisibles loss of 285 pounds, due to evaporation of moisture in the top.

The cost of the wool per pound of yarn is found as follows:

5,655 lbs. 3/8 blood Australian top 35 1/2 c.	$2,006.95
Waste, 280 lbs. 20 cents	56.00
Raw material cost of yarn, 5,090 lbs. 38.3 c.	$1,950.95

Tests of each grade of top are made to determine the percentage and value of waste and the amount of invisible loss. The data thus obtained are used for calculating the cost of yarn made from higher or lower priced top.

In the test just given we find that the 3/8 top yields 90 per cent. of yarn and 5 per cent. of waste, the latter worth 20 cents per pound, while there is an invisible loss of 5 per cent. The calculation of cost of yarn from top at a given price is shown by the following example:

Ex. Find raw material cost of yarn made from 3/8 top costing 32 1/2 cents per pound, with shrinkage and waste as given below.

100 lbs. top at 32 1/2 cents	$32.50
5 lbs. waste at 20 cents	1.00
90 lbs. yarn	$31.50

$31.50 ÷ 90 = 35 cents, cost of top for one pound of yarn.

Cost of Stock in Woolen Yarn

Calculating the cost of raw material in woolen yarn is based on the same principle as in the case of worsted yarn. A test of a large lot is first made to determine the amount of waste and yield of yarn. The value of the waste is then deducted from the cost of the lot, and the remainder, which is the cost of the raw stock in the yarn, is divided by the number of pounds of yarn to get the cost per pound.

Ex. The stock for a frieze fabric is composed of the following mixture:

20 per cent. Bagdad wool	18 cents
20 per cent. pulled wool	17 "
15 per cent. scoured wool	24 "
10 per cent. card waste	6 "

10 per cent. sweepings	4	"
5 per cent. headings	5	"
20 per cent. yarn waste	12	"

The stock yields 75 per cent. of yarn, the waste products being as follow:

10 per cent. card waste	6 cents
2 per cent. yarn waste	10 cents
3 per cent. invisible loss.	

Find the cost of the stock per pound of yarn.

The average cost of the batch is found as follows:

20 lbs.	Bagdad	.18	$3.60
20 "	pulled	.17	3.40
15 "	scoured	.24	3.60
15 "	card waste	.06	.60
10 "	sweepings	.04	.40
5 "	headings	.05	.25
20 "	yarn waste	.12	2.40
100 "			14.25

$14.25 ÷ 100 = 14 1/4 cents per lb.

Then:

100 lbs.	picked stock at 14 1/4 cents			$14.25
10 "	card waste	.06	.60	
2 "	yarn waste	.10	.20	.80
75 "	yarn cost			$13.45

$13.45 ÷ 75 = $.179, cost of stock per pound of yarn.

The waste in weaving is not included in the 25 per cent. shrinkage.

Cost of Stock in Cloth

The raw material received by the mill may be in the form of raw stock, such as cotton wool and shoddy, or partially manufactured material, such as worsted tops and yarn.

If partially manufactured its cost includes the cost of labor and other expenses in the processes through which it has already passed.

If the cloth is made of one grade of yarn only, cotton, woolen, worsted or other material, the cost of the raw material per finished yard is readily calculated from the original cost of the raw material, the weight of the finished goods, and the shrinkage between raw stock and finished cloth.

Ex. A worsted serge is made from 2/32s yarn costing 76 cents per pound. The by-product consists of 2 1/2 lbs. of yarn waste worth 25 cents a pound for every 100 lbs. of yarn. The waste of warp is negligible. The cloth loses 12 per cent. in weight during finishing, the value of the waste products, flocks, headings, etc., being negligible. Find the cost of yarn in one yard of cloth weighing 15 1/2 ounces.

100	lbs. yarn	.76	$76.00
2 1/2	" waste	.25	.63
97 1/2	" of woven cloth		$75.37

97 1/2 × .88 = finished weight, 85.8 pounds.

$75.37 ÷ 85.8 = $.878, cost of yarn per pound of finished cloth.

At this rate the cost of the yarn for one yard, 15 1/2 ounces of cloth is:

(.878 × 15 1/2) ÷ 16 = .85, cost of yarn per yard.
15 1/2 ounces.

Another method of calculation is as follows, taking the same example for illustration:

15 1/2 ÷ .88 = 17.61 ozs. woven cloth
17.61 ÷ .975 = 18.06 ozs. yarn per finished yard
18.06 × .025 = .45 ozs. yarn waste

18.06 ozs. yarn	.76	$.857
.45 ozs. yarn waste	.25	.007
Cost of yarn per yard		.85 per lb.

Ex. A worsted fabric is made with 4,200 ends 2/36s worsted, 65.5 inches in loom, 62 picks 2/36s worsted. The yarn costs $1.10 per pound. The waste in spooling, warping and weaving is 4 per cent.

of the total weight of the yarn and the loss of weight in finishing is 10 per cent. of the woven weight. The waste product is 3 per cent. yarn waste worth 25 cents per pound. Find the cost of yarn per finished yard weighing 12 ounces.

100 finished yards = 75 lbs. finished
75 ÷ .90 = 83 1/3 lbs. woven
83 1/3 ÷ .96 = 87 lbs. yarn

87 lbs. yarn × $1.10		$95.70
87 lbs. yarn × $1.10		
2.6 lbs. waste	.25	.65
100 yds. finished, .95 per yd.		$95.05

A frieze fabric made from a mixture costing 14 1/4 cents per lb. at the picker, weighs 30 ounces per yard. The loss of weight up to and including the weaving process is 27 per cent. The loss of weight in finishing is 18 per cent. The waste products are as follows:

15 per cent. card waste 6 cents
6 per cent. yarn waste 10 cents

Find cost of raw stock per pound and yard of cloth.

100 lbs. picked stock at 14 1/4 cents		$14.25
15 lbs. card waste at 6 cents	.90	
6 lbs. yarn waste at 10 cents	.60	1.50
73 lbs. woven cloth		12.75

$12.75 ÷ 73 = .175 cost of stock per woven pound
73 × .82 = 59.9 lbs. finished cloth
$12.75 ÷ 59.9 = .213 cost of stock per finished pound
(.213 × 30) ÷ 16 = .399, cost of stock per fin. yd., 30 ozs.

The same result is obtained from the cost per woven pound and the loss in finishing:

.175 ÷ .82 = .213, cost of stock per finished pound

Another direct method of calculation is based on the cost of the picked stock per pound and the shrinkage from picked stock to finished cloth:

.73 × .82 = 59.9 per cent. shrinkage from stock to finished cloth.
59.9 % fin. Cloth is of stock.

.1275 ÷ .599 = .213, cost of stock per pound per cloth.

Ex. A woolen cassimere is made of wool costing 56 cents per scoured pound. The shrinkage from scoured wool to woven cloth is 22 per cent., of which 9 per cent. is card waste valued at 8 cents per pound, and 4 per cent. is yarn waste valued at 14 cents per pound. The loss of weight in finishing is 16 per cent. Find cost of wool per yard of 15 1/2 ounces.

The value of the waste products are first deducted from the cost of the wool.

100 lbs. wool	.56		$56.00
9 lbs. card waste	.08	.72	
4 lbs. yarn waste	.14	.56	1.28
100 lbs. wool			54.72

$54.72 ÷ 100 = .547, net cost of wool per lb.
Material required per finished yard:

15.5 ÷ .84 = 18.45 ozs. woven
18.45 ÷ .78 = 23.65 ozs. wool.
23.65 ozs. .547 per lb. = $.809, cost of wool per yd.

The calculation can be varied as follows, the result being the same:

15 1/2 (ozs.) ÷ .84 = 18.45 ozs. woven yarn
18.45 ÷ .78 = 23.65 ozs. picked stock.
23.65 ozs. .547 per lb. = .809, cost of wool per yd.

When all the material in a fabric is of the same grade and cost, a calculation of the cost of raw material is best made from the finished weight per yard, loss in manufacturing and cost of raw material by weight as already explained. The calculation is simplified and chances of error reduced, as it is not necessary to calculate separately the weight of warp and filling per yard.

Cost of Material in Union Goods

The same method may also be used for finding the cost of material in union fabrics composed of two or more kinds of yarns having different values. The calculation is more complicated owing to the different degrees of shrinkage for the materials during finishing.

The cost of each materal is calculated separately. The different materials used in union cloths are subject to different degrees of loss in finishing. For this reason it is necessary to determine first the proportions of the different materials in a woven yard or cut. The cost per finished yard is then calculated from these proportions, the cost of the yarn and the loss of weight in finishing. The particular method to be adopted depends somewhat upon the composition of the fabric and can be best explained by practical examples:

Casket Cloth.

Ex. A cotton warp casket cloth is made with 3,000 ends 2/28s cotton, costing 20 cents per pound, 91 inches in the loom, 36 picks of 2 1/3 run yarn. The filling stock is made up:

5 per cent.	wool	65 cents
15 " "	cotton	15 cents
80 " "	shoddy	15 cents

Average cost, 17 1/2 cents.

The take-up of the warp is 6 per cent.; of filling, 5 per cent. The loss of weight from raw stock to yarn is 20 per cent., including weavers' waste. The woven cloth loses 75 per cent. of its weight in finishing. There is practically no loss in the weight of the cotton warp in finishing. The pieces gain 2 per cent. in length in

finishing. Find the cost of material per yard, 14 ounces. The goods are finished 70 inches wide.

The weight of cotton warp per finished yard is first calculated:

3000 ÷ .94 = 3191 yards warp.

3191 yards 2/28s cotton = 4.3 ozs. cotton yarn per woven yard.

This length of the warp is increased 2 per cent. in finishing, which makes the weight per finished yard as follows:

4.3 ÷ 1.02 = 4.2 ozs. cotton yarn per finished yard.

As the cotton loses nothing in weight during finishing, the 4.2 ounces represents the finished weight of the cotton.

The weight of the filling stock is next calculated:

14 ÷ .75 = 18.7 ozs. yarn per finished yard.

18.7 — 4.2 = 14.5 ozs. filling yarn per finished yard.

As the picked stock shrinks 20 per cent. to the woven cloth, we have:

14 1/2 ÷ .80 = 18.1 ozs. picked stock per finished yd.

The cost of stock is then calculated as follows:

4.2 ozs. cotton yarn	.20 per lb.	$.052
18.1 ozs. picked stock	.175 per lb.	.198
Cost of stock per finished yard		$.25

In this estimate the value of the waste products from such low-priced stock is so small as to be negligible.

This example shows how the presence of different materials in a fabric complicates the calculation based on weight, shrinkage and cost of raw material. That method is to be preferred, however, whenever it can be used, as it dispenses with the count, length and take-up of the yarn in the cloth except for calculating the proportion of the different materials, thus reducing the liability to error. Following is another method involving a separate calculation of the length and weight of each kind of yarn:

Ex. Same as preceding.

Take 100 woven yards as a basis.

$(100 \times 4.3) \div 16 = 26.0$ pounds cotton warp.
$(91 \times 36) \div .95 = 3448$ yds. filling per yard.
$3448 \div 233 = 14.8$ ozs. filling per yard.
$(14.8 \times 100) \div 16 = 92\ 1/2$ lbs. filling yarn.
$\$.175 \div .80 = .219$, cost per pound of yarn.
100 yards woven = 102 yards finished.

26.0 lbs. warp	20	$5.38
92.5 lbs. filling	.219	20.26
		$25.64

$\$25.64 \div 102 = \$.251$, cost of raw material per finished yard.

Worsted Serge.

Ex. Find cost of raw material in a worsted serge made as follows:

4088 ends 2/32s worsted, 63 inches wide in loom, 66 picks 2/32s worsted. Warp yarn costs $1.05; filling, $.95 per pound. Take-up 11 per cent. in warp, 5 per cent. in filling. Shrinkage in finishing 2 per cent.

$4088 \div .89 = 4593$ yards. 2/32s = 8.21 ozs. warp
$(63 \times 66) \div .95 = 4377$ yds. 2/32s = 7.82 ozs. filling

Woven weight		16.03 ozs.
8.21 ozs. warp	$1.05 per lb.	$.539
7.82 ozs. filling	.95 per lb.	.464
Cost per woven yard		$1.003

$\$1.003 \div .98 = \$1.023$, cost per finished yard.

The problem may consist (*a*) in calculating the cost of raw material from the lay-out, loss of weight in finishing and given weight per finished yard, or (*b*) from the lay-out and change in length during finishing. The former is generally the case when the goods have been made in sufficient quantity to show the average loss of weight in finishing, while the problem is found in the

latter form when calculating for new fabrics which have not yet been made and for which the loss of weight can only be estimated. The next two examples, referring to the same fabric, illustrate the two conditions.

Ex. Estimate the cost of raw material in a thibet, which is to be made to weigh 14 ounces per yard, 4000 ends 2/40s worsted, 83.3 inches wide, 52 picks 5-run woolen. Worsted yarn cost $1.11 per pound, and loses 5 per cent., of which 4 per cent. is worth 25 cents per pound. The picked stock for the woolen filling, consisting of 1/3 fine shoddy at 14 1/2 cents and 2/3 wool at 60 cents per pound, loses 15 per cent., of which 10 per cent. is waste worth 7 cents per pound. Take-up 6 per cent. in warp and 5 per cent. in filling. Shrinkage in length in finishing, 10 per cent.

100 yards of dressed warp is taken as a basis.

100 yards of warp. 4000 ends 2/40s worsted = 35.7 pounds warp. A warp take-up of 6 per cent. gives 94 woven yards.

$(83.3 \times 52) \div .95 = 4569$ yards filling

$4569 \div 500 = 9.14$ ozs. filling

$(9.14 \times 94) \div 16 = 53.7$ lbs. filling

Cost of warp yarn.	100 lbs.	$1.11	$111.00
	4 lbs. waste	.25	1.00
	95 lbs. yarn		$110.00

$1.10 ÷ .95 = $1.16, cost of worsted per woven pound

Cost of filling stock.	33 lbs. shoddy	.145	$4.78
	67 lbs. wool	.60	40.20
	100 lbs.		$44.98
	10 lbs. waste	.07	.70
	85 lbs. yarn		$44.28

$44.28 ÷ .85 = $.521, cost of filling per woven pound

37.7 lbs. warp at	$1.16 =	$41.41
53.7 lbs. filling at	.521 =	27.98
Total		$69.39

$94 \times .90 = 84.6$ yards, finished.

$69.39 ÷ 84.6 = $.82, cost of stock per yard finished.

Ex. After this thibet fabric had been manufactured for some time it was found to lose 4 per cent. from yarn to woven cloth and 17 per cent. in finishing. Estimate cost of raw material per 14-ounce yard.

4000 ends 2/40s worsted with 6 per cent. take-up — 6.08 ounces warp
83.3 inches wide, 52 picks 5-run with 5 per cent. take-up — 9.12 " filling
15.2 "

Woven weight per yard:

6.08 ozs.	$1.16 per lb.	$.440
9.12 ozs.	.52 per lb.	.296
15.2 ozs.		$.736

$.736 ÷ 15.2 = $.0484

.0484 ÷ .96 = .0504, cost of yarn per woven ounce.

.14 ÷ .83 = 16.9 ozs. woven cloth per finished yard.

16.9 ozs. $.0504 = $.852, cost of yarn per yard finished.

Ex. Find the cost of raw material in a cotton warp beaver made as follows:

3840 ends dressed 2 face, 3 1/2 runs, 1 backing 14s cotton, 77 1/2 inches wide, 54 picks, woven 2 face 4 1/4 runs, 1 backing 7/8 run. Take-up 7 per cent. in filling. Shrinkage in length in finishing, 8 per cent.

Stock for face warp:

20 per cent. cotton	$.08 1/2
40 per cent. wool	.60
40 per cent. shoddy	.14 1/4

Loss to woven cloth 20 per cent., of which 15 per cent. is valued at 5 cents per pound. Cotton warp yarn, 22 cents per pound, no waste.

Stock for face filling:

10 per cent. cotton	$.08 1/2
35 per cent. wool	.60
55 per cent. shoddy	.14 1/4

Loss to woven cloth 22 per cent., of which 15 per cent. is valued at 5 cents per pound.

Stock for back filling:

5 per cent. wool	$.32 1/2
15 per cent, cotton	.08 1/2
80 per cent. waste	.06

Loss to woven cloth 35 per cent.; waste of negligible value.

The cost of material per pound of woven cloth is found as already explained:

Face warp	$.383
Cotton warp	.22
Face filling	.371
Back filling	.118

The quantity of material in one woven yard is next found:

1289 ÷ .93 = 1376 yards 14s cotton warp = 1.87 ozs.
2560 ÷.93 = 2753 yards 3 1/2 run warp = 7.86 "
(77.5 × 36) ÷ .95 = 2937 yds. 4 1/4 run filling = 6.91 "
(77.5 × 18) ÷ .95 = 1468 yds. 7/8 run filling = 16.77 "
Weight per woven yard: 33.41 "

These weights per yard are extended at their respective values:

1.87 ozs. cotton warp	.22	$.026
7.86 ozs. face warp	.383	.188
6.91 ozs. face filling	.371	.160
16.77 ozs. back filling	.118	.123
Cost of material per woven yard		$.497

$.497 ÷ .92 = $.54, cost of material per finished yard.

Whenever possible, it is preferable, as already stated, to calculate the cost of material, as in the above examples, on the weight of the finished goods and the loss of weight in manufacturing.

Cost of Manufacturing

As already explained, the cost of raw material per yard is easily calculated from the weight of the cloth, loss of weight in manufacturing, and original cost of raw material. With these quantities and values known, the estimate of cost of raw stock per yard is easily made. The calculation of the cost of labor and other expenses per yard, however, is a work of considerable difficulty because of the large number of widely different fabrics frequently made in the same mill. While estimating the cost of labor and other expenses per yard is a complex problem it can be greatly simplified by a method adapted to the conditions in the mill in which the goods are made.

If a mill is running steadily on one grade of plain cloth, making no change in the quality or construction of the fabric and buying raw material in only one form, the cost of labor and other expenses per yard is easily found by dividing the total of such items for any given period by the number of yards manufactured in the same time.

Exceptional conditions, such as the falling behind of the work in the finishing room or an increased product in the same room, due to catching up with the work after it has fallen behind, might make a test for a short period unreliable by reason of a production below or above normal. There are many other variations that would make a short test unreliable, such as the payment or non-payment of expenses like insurance and taxes, which fall due only at long intervals, and which should be spread over a period of six months or a year. Thus even in a plain goods mill, it is nec-

essary to have the statement cover a period of considerable length. The nearer it approaches the fiscal period, the nearer will the result approach the actual cost of production.

The following example taken from a New England flannel mill making one grade of white flannel on which the cost of labor was reckoned by the pound, will illustrate this elementary method of determining the cost of manufacturing. The other items of expense were not given in this case, but can be calculated by the pound in the same way:

Woolen flannel mill, 13 sets cards, 7.480 spindles.
Total cost of labor for 6 months, $42,912.
Cloth finished same period, 251,873 pounds.
Cost of labor per pound of cloth, 17 cents.

The entire product consisted of a piece-dyed, woolen sacking 50 inches wide, weighing 7 1/2 ozs. per yard and made as follows: 2100 ends 5 runs, 63.6 inches wide in loom, 32 picks, 5 runs.

It is evident that the cost of manufacturing can be very accurately determined by ths simple method, providing the mills are kept in operation and the production of each department is kept equal to the others during the period covered by the statement.

The application of this method, however, is necessarily limited to mills making only one kind of cloth. When two or more fabrics are made in the same mill, the calculation fails to give the cost of either.

Let us assume, for illustration, that a mill is making the piece-dyed flannel given above and also a wool-dyed cloth made as follows:

1000 ends 1 5/8 run,, 7 1/2 x 2 reed, 67 inches in loom, 20 picks 2 run. Finished 55 inches wide, 12 ounces per yard.

Following are a few of the items of cost which vary widely for the two fabrics:

Dyeing. Higher for the new cloth which is dyed in the wool.

Carding and spinning. Lower for the new cloth which is made of 1 5/8 and 2 run yarn while the old fabric is made from 5-run yarn. A woolen card would produce three of four times as much roving for the coarser yarn as for the finer.

Weaving. Lower for the new cloth, which is woven with 20 instead of 32 picks.

Finishing. Higher for the new cloth, which requires more care in burling, sewing, fulling, gigging, shearing, and specking.

Fixed charges. Lower per pound for the new cloth because of the increased production of the card on the new yarn.

For some items, dyeing and finishing, the cost of the new goods is higher, while for other items, carding, spinning, weaving and fixed charges, the cost is lower than for the old cloth. The problem is to determine the actual cost of each fabric. This cannot be done by assuming the average cost of the total product of the mill to be the cost of the two cloths, because the probabilities are that the increase of certain items of expense in the case of the new cloth will not be equal to the decrease of other items. For this reason the cost of each process must be calculated separately for each fabric.

Taking for illustration the cost of carding and spinning for the two fabrics above mentioned, the calculation is made as follows:

We will assume that the cost of carding and spinning in this mill is 90 cents per hundred runs for labor,

and 10 cents per hundred runs for supplies. These rates are obtained from the semi-annual cost statements of the mill. The number of runs of yarn in 1 cut of each fabric is calculated as follows:

Old Cloth; 146 runs per cut.
Labor, 146 runs .90, $1.31 per cut.
$1.31 ÷ 50 = $.026 per yd. finished.
Supplies, 146 runs .10, $.15 per cut.
$.15 ÷ 50 = $.003 per yd. finished.
New Cloth; 84 runs per cut.
Labor, 84 runs $.90 per C. $.76 per cut.
$.76 ÷ 48 = $.016 per yd. finished.
Supplies .84 runs $.10 per C. $.08 per cut.
$.08 ÷ 48 = $.002 per yd. finished.
Carding and Spinning, per yard:

	Old Cloth	New Cloth
Labor	$.026	$.016
Supplies	.003	.002
Total	.029	.018

Essentials in Cost Finding

Illustrations could be taken from every department of the mill showing that, in order to determine the cost of a fabric in a mill making two or more fabrics, it is necessary:

First, to keep an accurate record of the actual production and cost of each department or process of manufacturing in the mill in question, and of the items of general cost which are not properly chargeable to any particular process. The average cost of each department is based on the respective units of production, the grease weight by the pound for sorting, the scoured weight by the pound for picking, the number of runs for carding and spinning, the section cut for warping, and the equivalent yardage based on an as-

sumed number of picks per inch, say 50, for the weave room expenses other than piecework, and for the fixed charges of the mill.

Second, to calculate the quantity of material that must be put through each process to produce a given quantity of the fabric on which a cost estimate is desired, extend these quantities at the actual average of cost in the respective departments, and from the total of the items thus obtained for the given quantity, calculate the cost per yard or pound of finished goods.

The value of such an estimate depends on the accuracy with which the quantities of material and the cost of labor and supplies in each department are determined. An explanation of the calculations to determine the quantity of material that must be put through each process for a given quantity of cloth is given in *"Straight Line Textile Calculations,"* and need not be repeated here.

The cost of labor and supplies in each department is obtained from the records of the mill. Special and periodical reports are required for this purpose. The particular form adopted is immaterial providing the desired information is obtained. The form will have to be adapted to the special needs of each mill.

Record of Production and Cost

Two kinds of statistical statements should be issued. One covers a short period, say a month, the other, six months or a year. When the payroll is made up weekly much labor can be saved in compiling the cost statements by making each cover a number of complete weeks, each period ending with the last Saturday of each month. These statements not only serve as a basis for estimating the cost of particular fabrics, but also show at regular intervals the production, cost and efficiency of the various departments of the mill.

Owing to the unavoidable fluctuations in mill work a statement for a period of four weeks cannot safely be taken as the average for the year or half-year. This average is obtained by compiling annual or semi-annual statements showing the production and cost of each department. The illustrations show statements of cost for three mills, the Arbela Woolen Mills, the Bayard Woolen Mills and the Chantilly Worsted Mills. These are based on actual operations and disclose, not only the production and cost in each mill, but also by comparison certain shortcomings in the operation of the three mills.

The name of the mill, period covered, and the machinery in operation appear at the top of the report.

In the first column the department of manufacturing or item of cost is given; in the second, the production for the period named; third, the amount paid for labor; fourth, the expenses other than labor; fifth, average cost of labor per unit of production; sixth, average cost of other expenses per unit of production.

The production of each department of manufactur-

ing is given in the second column in the respective units:

Wool Sorting. Weight of grease wool sorted.

Scouring and Dyeing: Clean weight of wool, yarn or cloth dyed.

Pcking: Weight of stock picked.

Carding and Spinning: The number of runs (1600 yards) of yarn spun. The runs of yarn per woolen card and per spindle in 10 hours and the average size of the yarn spun are given for comparison.

Spooling and Dressing: Section cuts dressed. One cut dressed with 6 sections counts as 6 section cuts.

Weaving: Cuts; actual yardage; equivalent yardage based on 50 picks per inch. The average picks per inch, ounces per yard and efficiency of the looms are given for comparison.

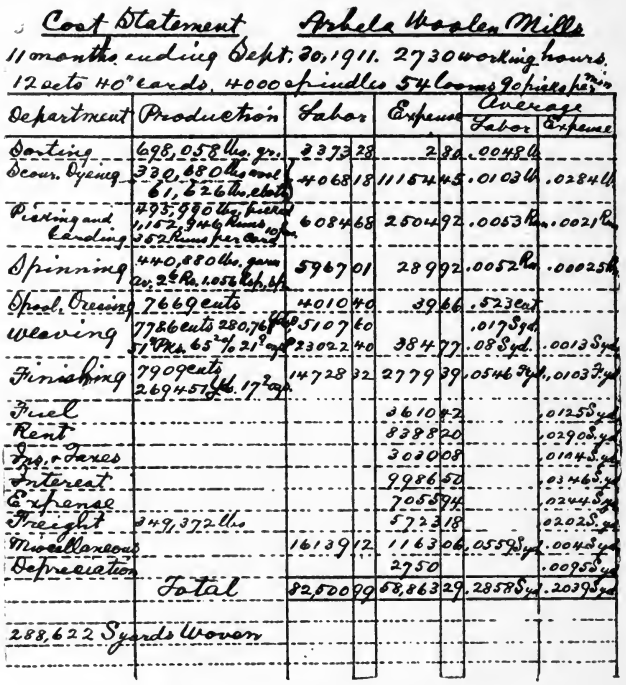
Finishing: Finished yardage. The cuts, ounces per yard and total weight are given for comparison.

A separation of the day labor from the spinning wages in the spinning department, as in the Bayard Mills, discloses whether any change in the cost of spinning is due to changes in the wages of the day hands or spinners.

The number of cuts woven and finished shows the balance of production between these two connecting processes. The production of the finishing room is given in finished yards.

The production of the looms is measured in yards. The number of picks per inch has an important influence on the yardage. As the average picks per inch are constantly varying in a mill making a number of fabrics, the yardage does not indicate the efficiency of the looms. The less picks per inch the greater the length woven.

For this reason it is necessary to reduce the actual yardage to an equivalent number of yards woven with a standard number of picks. In the three statements 50 picks per inch is taken as the standard. In the Arbela Mills the actual number of picks per inch was



Cost Statement Arbela Woolen Mills

11 months ending Sept. 30, 1911. 2730 working hours.
12 sets 40" cards. 4000 spindles 54 looms 90 picks per min

Department	Production	Labor	Expense	Average Labor	Average Expense
Sorting	698,058 lbs. gr.	3373 28	2 80	.0048 lb	
Scour. Dyeing	330,680 lbs wool 61,626 lbs. cloth	4068 18	11154 45	.0103 lb	.0284 lb
Picking and Carding	495,990 lbs. picked 1,152,946 Rums 10 per 352 Rums per card	6084 68	2504 92	.0053 Rm	.0021 Rm
Spinning	440,880 lbs. garn av. 2.6 Rs. 1.056 Rsp. bf.	5967 01	289 92	.0052 Rm	.00025 Rm
Spool. Dressing	7669 cuts	4010 40	39 66	.523 cut	
Weaving	7786 cuts 280,761 yds 51 Pks. 65 2/10 21 ozs	5107 60 23022 40	384 77	.017 Syd. .08 Syd.	.0013 Syd
Finishing	7909 cuts 269451 yds. 17 2/10 ozs.	14728 32	2779 39	.0546 Fyd	.0103 F. yd
Fuel			3610 42		.0125 Syd
Rent			8388 20		.0290 S. yd
Ins. & Taxes			3030 08		.0104 S. yd
Interest			9986 50		.0346 S. yd
Expense			7055 94		.0244 S. yd
Freight	349,372 lbs		5723 18		.0202 S. yd
Miscellaneous		16139 12	1163 06	.0559 Syd	.0045 Syd
Depreciation			2750		.0095 Syd
	Total	82,500 99	58,863 29	.2858 Syd	.2039 Syd
288,622 Syards Woven					

FIG. 1. RECORD OF PRODUCTION AND COST

51.4, consequently the actual length woven, 280,761 yards, is equivalent to 288,622 yards having 50 picks per inch:

$$(280{,}761 \times 51.4) \div 50 = 288{,}622.$$

On the other hand, the 347,241 yards woven in the Bayard Mills averaged 44.29 picks per inch. This is

equivalent to 307,586 standard yards of 50 picks per inch:

$$(347{,}241 \times 44.29) \div 50 = 307{,}586.$$

In the former case the standard yardage is greater than the actual because the average picks, 51.4, are in

Cost Statement Bayard Woolen Mills
6 months ending May 31, 1913. 1466 working hours
27 sets cards 9960 spindles 110 looms 80 picks per min.

Department	Production	Labor	Expense	Average Labor	Average Expense
Sorting	353,161 lbs.	1422 47	11 89	.004 lb.	
Wool Scour & Dye	208,672 lbs. scd.	1216 98	989 72	.0058 lb.	.0047 lb.
Picking	564,585 lbs.	1141 74	1624 49	.002 lb.	.0029 lb.
Carding	1,378,285 Runs 348 Runs per set 10 hrs	6695 51	1795 50	.0049 Rn.	.0013 Rn.
Spinning	Av. 2,98 Runs day .94 Run per sp. 10 hrs.	2638 19 8809 32	304 33	.0019 Rn. .0064 Rn.	.0002 Rn.
Dressing and Spooling	8960 cuts Av 7.7 sec. 69,350 sec. cuts	3869 84	151 11	.0558 sec. cut	.0022 sec. cut
Weaving	347,241 yds 44.2 Pk. 512,175 lbs. 23.6 ozs.	6010 33 22667 82	550 14	.0195 Syd.	.0018 Syd.
Pc. Dyeing	268,881 yds.	1418 52	9395 21	.0053 yd.	.0349 yd.
Bur Dyeing	7221 cuts	653 79	2372 27	.09 cut	.3285 cut
Fulling	7323 cuts	2453 08		.335 cut	
Tigging	4324 cuts	3895 99		.901 cut	
Dry Finish		8221 19			
Total Men's Wear Finish	231,211 yds. 24.5 ozs. 355,049 lbs.	14570 26	5264 72	.063 yd.	.0228 yd.
Dress Goods Finish	152,127 yds. 5.2 ozs. 49,055 lbs.	1219 59	608 99	.008 yd.	.004 yd.
Iron & Wood		3548 38	717 87	.0115 Syd.	.0023 Syd.
Fuel	1787 tons coal	1922 76	8063 48	.0062 Syd.	.0262 Syd.
Freight			1524 11		.0049 Syd.
General		5916 18	1732 06	.0192 Syd.	.0056 Syd.
Samples		438 60		.0014 Syd.	
Depreciation			3500		.0113 Syd.
	Total	84160 28	38605 89	.321 Syd.	.1255 Syd.
307,586 Syards Woven					

FIG. 2. RECORD OF PRODUCTION AND COST

excess of the standard of 50. In the latter case the standard yardage is less than the actual because the

Cost Statement Chantilly Worsted Mill

28 weeks ending June 20, 1916 1359 working hours

12 sets woolen cards 4848 woolen spindles 7 combs 4320 wors. spin. 152 looms

Department	Production	Labor	Expense	Average Labor	Average Expense
Sorting	285,984 lbs. at loom 114,897 " on floor 177,317 " woolen	2541 32	17 29	.0063 lb.	
Dcomg. & Dyeing	320,436 " worsted	976 18	47 284	.002 lb.	.00096 lb.
Wln. Pick & Card	373,294 lbs. 265,450 lbs.	3393 56	1314 62	.0091 lbs.	.0035 lbs.
Woolen Spinning	373,294 lbs. 204,200 lbs. Dr. 1.82 lbs. .56 lbs.	1239 44 2135 55	181 17	.0033 lbs. .0057 lbs.	.0005 lbs.
Worsted Card'g & Comb'g	210,577 lbs. to 68 223,916 lbs. roll's card'd	3278 44	329 47	.0155 lb.	.0016 lb.
Worsted Drawing	193,498 lbs. rov'g 2.84 lb. per 100 sp. 10 hrs	3508 38	137 16	.0181 lb.	.0007 lb.
Worsted Spinning	193,157 lbs. yarn .301 lb. per sp. 10 hrs	4647 94	271 84	.024 lb.	.0014 lb.
Worsted Wind'g & Twist'g	113,743 lbs.	3439 71	186 29	.0302 lb.	.0016 lb.
Worsted Spooling	125,199 lbs.	2222 04	79 43	.0177 lb.	.00063 lb.
Woolen Spooling	114,800 lbs.	746 38	64 15	.0065 lb. (1000 lb.)	.0005 lb. (1000 lb.)
Dress. Stock'g	297,302 yds. Ca. 2783 lbs.	1893 76	112 48	.0001 84 yd.	.00001 yd.
Weaving	299,400 yds. 50,4 Pks. 433,880 lbs. 23,2 sp.	6088 80 2055 44	6438 1	.0201 5 yd. .0681 5 yd.	.0022 yd.
Samples		1843 73	76 40	.0065 yd.	.00025 yd.
Yarn Wood		10353 84	3421 15	.0334 5 yd.	.0116 5 yd.
General		11249 41	2342 86	.0373 5 yd.	.0077 5 yd.
Burl'g & Sew'g	299,400 yds. woven	5880 55	842 3	.0179 5 yd.	.0003 5 yd.
Finishing	320,896 yds. wet Dry	4272 69 4021 95	2763 42	.0133 5 yd. .0125 yd.	.0086 yd.
Wool & Piece Dyeing	159,060 lbs. raw & wet 156,240 lbs. cloth	1958 14	1262 59	0.0062 lb.	.014 lb.
Fuel & Power			1362 73		.0045 5 yd.
Freight			651 42		.0021 5 yd.
Insurance			509 60		.0016 5 yd.
Taxes			1296 47		.0042 5 yd.
Interest			1474 60		.0048 8 yd.
Depreciation			3769 22		.0125 8 yd.
Total		95744 24	49,722 55	.3172 8 yd.	.1647 3 yd.
301,795 Sq yards.					

FIG 3. RECORD OF PRODUCTION AND COST

actual picks, 44.29, are less than the standard, 50. This yard of 50 picks per inch is called the standard and is marked "S yard" on the statements.

Fixed Charges Per Yard

The production of the mills in standard yards serves as a basis for calculating the average for the fixed charges. Take, for example, the fuel cost, $3,610.42, in the Arbela Mills. This divided by 288,622 gives $.0125 as the cost of fuel per standard yard.

The fixed charges include all expenses that cannot be directly charged to some particular process of manufacture, such as rent, insurance, taxes, fuel, etc.

The cost of weaving, other than the weavers' wages, is included for convenience in the general charges, for which the averages are based on the standard yard of 50 picks per inch.

A defect of the Arbela Mills statement is that too many items are included under "Miscellaneous." Stating the labor cost for iron and wood work and fuel separately, as in the report of the Bayard Mills, is preferable, as it gives a better view of the details of the general expense account.

This defect is even more marked in the expense of the Chantilly Mills, as some of the expense has been apportioned among the operating departments, except in the case of the dyehouse. The labor cost of the Chantilly mill is, however, classified better than in either of the other two mills.

In the column marked "Average" is placed the average cost of labor and expense calculated by the unit of production for each department. Thus the cost of sorting is given per pound of grease wool; of carding

and spinning, per run of spun yarn; of spooling and warping in the Arbela Mill, per warp cut; in the Bayard Mills per section cut; and in the Chantilly Mills per yard of 1,000 ends; of day weaving, per standard yard; of piece dyeing in the Bayard Mills, per yard, and in the Chantilly Mills, per pound. In the Bayard Mills fulling, gigging and bur dyeing were such important and distinct processes that they are classified separately.

From these periodical statements a list of cost averages is made up for use in estimating the cost of individual fabrics. If the mill in quetion is up-to-date in every respect, and equipped to produce cloth at a cost as low as or lower than its competitors, the averages are taken as found in the statement, and the estimate of cost then made for each fabric, as will be more fully explained further on. A test of the accuracy of these estimates is made after an inventory has been taken and the mill books closed. The yardage of each style shipped from the mill is extended at the estimated cost and the total compared with the actual cost as shown by the mill books. The Arbela Mills were well suited to stand such a test, as they were well arranged and handicapped by no serious defect in equipment.

In the Bayard and Chantilly Mills the conditions were different. The Bayard Mills were handicapped by antiquated machinery, particularly in the spinning department, and by an expensive power plant. The cost at the Chantilly Mills was excessive owing to the high cost for fuel and iron and wood work. We find the cost of fuel in the three plants to be:

Arbela Mill	.0125 per S yd.
Bayard Mill	.0262 " "
Chantilly Mill	.0451 " "

The cost of labor for iron and wood work in the Bayard and Chantilly Mills was:

Bayard Mill	.0115 per S yd.
Chantilly Mill	.0334 " "

The average size of yarn spun in the Arbela and Bayard Mills was nearly the same. The labor cost of spinning was as follows:

Arbela Mill	.49 per 100 runs
Bayard Mills	.83 " 100 "

Frequently market conditions are such that the margin of profit either disappears entirely or becomes so small that only the best mills can avoid a loss. At such times an estimate of the cost of a fabric, based on the actual cost of the goods in a mill handicapped as were the Bayard and Chantilly Mills, will be above the net selling price of the goods. If the manager of such a mill offers the goods at prices based on actual cost, the prices will be so high as to prevent a sale. If he sells at the market price the mill will show a loss.

The mill owner has two other courses open under such conditions. The mill can be remodeled to enable goods to be manufactured at less cost, or the excess of cost due to the operation of old machinery can be charged to the old equipment, the estimates of cost in the meantime being based upon what the cost should be, instead of what it is. The application of the latter policy is, of course, limited by the financial resources of the manufacturer.

Cost Averages

A list of cost averages for the different departments is made up from the mill statements covering a period of at least six months, during which the mill was in full operation. These averages are used for estimating the cost of individual fabrics. Care should be taken to compile the averages from a period during which the production of the department was not decreased by any unusual cause, such as stopping of machinery, etc., otherwise the estimates will be too high. With a fair production the averages show the best that can be expected in actual operation of the plant.

The list of cost averages is made up in the following form for reference:

Cost Averages for Processes:

	Labor	Expense
Sorting per lb.	$.004	
Scouring and dyeing	.006	Special
Picking and carding per run	.005	.002
Spinning per run	.005	.0002
Spooling and dressing, section cut	.055	
Weaving, other than price list	Fixed	
Piece dyeing per yard	.005	Special
Finishing per yard	.055	.01
Fixed Charges per S Yard of 50 Picks:		
Day labor	.019	.002
Iron and wood	.011	.002
Fuel	.006	.026
Freight		.005
General	.019	.006
Insurance and taxes		.01
Interest		.034
Depreciation		.011
Rent (Interest on plant)		.029
Total fixed charges	.055	.125

These averages enable estimates of cost to be made, not only for each fabric made in the particular mill, but for any fabric made by a competitor, and are consequently invaluable in measuring and meeting competition.

Cost Statement. Worsted Yarns. Dept. Chantilly Mills
28 weeks ending June 20, 1916. 1359 working hours
7 Combs 4320 Spindles

Department	Production	Labor		Expense		average Labor	average Expense
Sorting	352,480 lbs.	2220	62	15	21	.0063 lb.	
Scour. & Dry.	320,436 "	640	87	307	62	.002 "	.001 lb.
Carding and Combing	210,577 lbs. tops 23,916 " noils	3278	44	329	47	.0155 "	.0016 "
Drawing	193,498 lbs.	3508	38	137	16	.0181 "	.0007 "
Spinning	193,157 lbs. 30.6 10.07 hks. p. sp. hr.	4647	94	271	84	.00079 hk.	.000046 hk.
Wind. & Twist.	113,743 lbs.	3439	71	186	29	.0302 lb.	.0016 lb.
Spooling	125,199 lbs.	2222	04	79	43	.0177 lb.	.0006 "
Iron & Wood		2070	77	684	30	.00035 hk.	.00001 hk.
General		2249	88	468	56	.00038 "	.00005 "
Fuel				2725	34		.00046 "
Freight				130	28		.00002 "
Insurance				101	92		.000017 "
Taxes				259	29		.000043 "
Interest				2948	92		.0005 "
Depreciation				753	84		.00013 "
	Total	24278	65	9399	47	.00411 hk.	.00159 hk.
5,910,604 hanks							

FIG. 4. RECORD OF PRODUCTION AND COST

The cost of dyeing should be estimated separately for each fabric owing to the wide variations in this item.

The day labor in the weave room is treated as a fixed charge.

Cost of Each Fabric

The regular reports, monthly, semi-annual or annual, show the production, total cost and average cost per unit of production in each department and for each item of general expense. These records not only show the operations of the mill and enable comparisons to be made between different mills, but they also supply the basis for estimating the cost of each fabric.

These estimates of cost are made for the fabrics manufactured in the mill, in order that the proportionate cost that should be borne by each may be known and the selling price fixed accordingly. The estimates of cost are also made for fabrics manufactured in other mills in order that the manufacturer may be able to judge intelligently of the competition he has to meet, or may be able to decide whether a given fabric, if made in his mill, would be likely to yield a profit.

The statistical uses of the cost records have already been explained and it now remains to illustrate the estimates of cost based on the mill records. The method of estimating cost is shown at Fig. 5, which is an estimate of the cost of a cotton warp fabric. The style number, woven and finished widths and weights, and the dressed, woven and finished lengths of the piece, are first given. Then comes the estimate of the quantity and cost of the stock to make a cut of the cloth. The quantities of yarn required are calculated by the methods explained in *"Straight Line" Textile Calculations.*

Raw Material Cost

The prices for the materials are fixed by the manufacturer to conform to the market conditions on which he wants the estimate based. It may be desirable to

No. 47

ESTIMATE OF COST

Date. May 17. 1916

STYLE. 3704

Length Dressed, 40 yds. Weight Woven, Width Woven, 75.3 in.
Woven, 37 " Finished, 28 ozs. Finished, 55 in.
Finished, 33.3 "

STOCK.

USE.	SIZE.	ENDS.	PICKS.	Yarn Per Yd.	Yarn Per Cut	PRICE.	Total per Cut		Per Yd. Finished
Face Wp	5 Rs	2560		5.1 ozs	1 23/4 lb	.67	8	54	.256
Back Wp	145 Cott	1280		1.7 "	4 1/4 "	.21 1/2		91	.027
Face Fill	5 1/4 Rs		40	5.4 "	12 1/2 "	.67	8	38	.252
Back Fill	7/8 Rs		20	17.2 "	39.7 "	.15 3/4	6	25	.188
			60	29.4			24	08	.723

MIXTURE OF STOCK.

Face Wp. & Fill
50 lbs Cape .70 $35.
50 " Texas .50 25.
60.
10 lbs Waste .10 1.
59.
12% loss
Yarn .67 per lb.

Back Fill. $
40 lbs. Cotton .10 4.
20 " Noils .17 3.40
20 " Noils .21 4.20
20 " Waste .05 1.
12.60
20 lbs loss
Yarn .15 3/4 per lb.

MANUFACTURING.

PROCESS, ETC.	Quantity per cut.	AVERAGE. Labor.	AVERAGE. Supplies.	TOTAL PER CUT. Labor.		TOTAL PER CUT. Supplies.	
Sorting	82 lbs.	.004			328		
Scouring	28 "	3.67	1.25		102		035
Picking	76 "	0032	0029		243		22
Carding	182 Runs	0046	0008		837		145
Spinning	182 "	008	0002	1	456		037
Spool. & Dress.	6 Sec	0569	0047		341		023
Weav. Day	37 Yds.	025	0031		925		114
" Piece	37 "	096		3	55		
Piece Dyeing	37 "	007	024		259		888
Finishing	33.3 "	0597	016	1	988		532
Iron & Wood	37 "	0187	0044		692		163
Fuel	37 "	008	0292		296	1	08
Ins. & Tax.	37 "		0132				488
Freight	37 "		0096				355
General	37 "	0324	0102	1	20		877
			Total.	12	217	4	457

COST PER FINISHED YARD.

Stock. .723
Labor. .367
Supplies. .134

Total. 1.224

FIG. 5. ESTIMATED COST OF A COTTON WARP FABRIC

base the estimate on the actual cost of the raw stock or on the cost of the material if purchased when the estimate is made and which may be above or below prevailing prices.

When two or more grades of stock are mixed together before manufacturing, the average cost is calculated in the column headed "Mixture of Stock," allowance being made for shrinkage from raw stock to yarn and for the value of the by-products. The result is the cost of stock per pound of yarn, at which the respective quantities are extended in the columns headed "Stock." The total cost of raw material per cut of cloth is found by adding the items as shown.

Cost of Manufacturing

Next comes the cost of manufacturing. The method consists in first calculating the material that must be passed through each department of the mill to make a cut of cloth. The estimate for the fixed charges is based on the production of the looms as measured in standard yards of cloth with 50 picks per inch. Accordingly the woven length, 37 yards, is placed opposite each item of general expense and extended at the proportionate price per standard yard. Take for illustration the cost for general labor. The mill record shows this item to be $.027 per standard yard of 50 picks per inch. The fabric, Style 3704, is woven with 60 picks, making it necessary to increase the average cost per standard yard by 20 per cent. Thus:

($.27 × 60) ÷ 50 = $.0324, general labor per yard.

It is not necessary to make this calculation for every estimate. After the averages per standard yard for

the various items are obtained from the mill records, they are increased or decreased to correspond to different filling sets, say from 20 to 70 picks, and arranged in tabular form so as to be ready for use when required. For example, the average per yard for general labor would be $.0216 for 40 picks; $.027 for 50 picks; $.0324 for 60 picks; with other filling sets in proportion.

The quantities of material passed through each department to make a cut of the cloth, having been entered in the column headed "Quantity per Cut," are extended as shown at Fig. 5, at the respective cost averages obtained from the mill records, the amounts being entered under "Labor" and "Supplies." The general expense items are extended and entered in the same columns. The total of these extensions is the cost per cut for labor and for expense.

We now have estimated the cost per cut for raw material, labor and supplies, the cost per finished yard being found by dividing these totals by the number of yards in a finished cut:

Stock	$24.08 ÷ 33.3 =	$ .723	per yard
Labor	12.22 ÷ 33.3 =	$ .367	per yard
Supplies	4.46 ÷ 33.3 =	$ .134	per yard
Cost per finished yard		1.224	

The cost thus found covers all expenses for stock and manufacturing at the mill and is the estimated cost of the cloth as it leaves the mill. The cost of selling, which is estimated separately, is usually based on the selling price of the goods. If, for example, the selling cost has been found to be 20 per cent. of the sell-

ing price, the total cost of the cloth, Style 3,704, including selling expenses, will be:

$1.224 \div .80 = \$1.53.$

Any increase of the selling price above this cost represents profit subject to the deduction of 20 per cent. for the cost of selling. If, for example, this style, 3,704, was sold for $2.00 per yard, the profit would be as follows:

Selling price	$2.00
Selling cost	.40
	1.60
Mill cost	1.224
Profit	.376

The blank form used for the estimate at Fig. 5 can be dispensed with if desired. After the cost averages have been obtained from the mill records and the method of estimating is clearly understood, it is possible to enter these estimates in an ordinary blank book, say 5 in. x 8 in., abbreviating many of the operations without impairing their accuracy. Time is saved in this way and the estimates are kept together in a convenient form for reference and comparison. Figs. 6 and 7 are estimates made in this way for a woolen frieze and worsted serge. The dressed, woven and finished lengths of a cut are at the left of the style number. The percentages below the stock mixture are for the losses in manufacturing, the first from loose stock to yarn, and the next from yarn to finished cloth. The quantity of stock is calculated from the finished weight and percentage of loss, this method, which is both accurate and direct, being possible only when the fabric is made of one mixture throughout. Take for illustration Style 624, Fig. 6:

34 (ozs.) ÷ .84 = 40.5 ozs. yarn
40.5 (ozs.) ÷ .70 = 57.8 ozs. stock

The accuracy of this result depends upon the accuracy with which the losses between raw stock and yarn

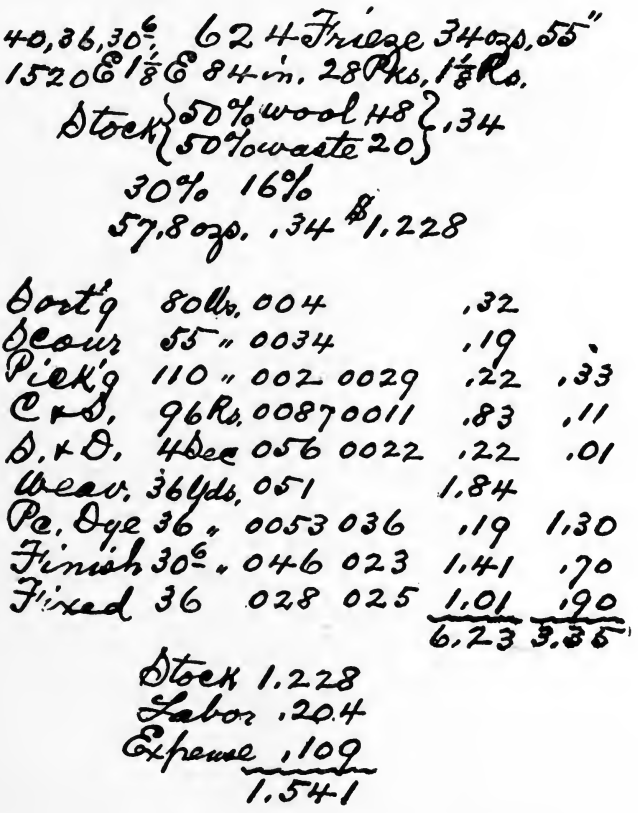


FIG. 6. ESTIMATED COST OF A FRIEZE

and between yarn and cloth are determined. These percentages can be determined closely by tests of goods going through the mill.

Cost of Manufacturing Worsted Yarn

When worsted spinning and weaving are carried on in the same mill, it will generally be found more satisfactory to separate the cost account of the worsted department, calculate the cost of worsted yarn per pound,

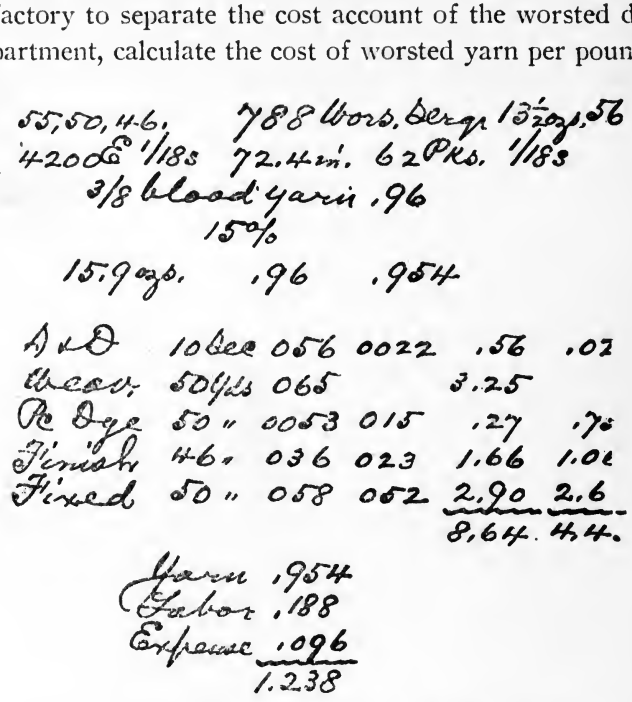


FIG. 7. ESTIMATED COST OF A WORSTED SERGE

and then estimate the cost of each worsted fabric as if the yarn had been purchased instead of made in the mill in which the cloth is woven. Nearly every weaving mill to which a worsted spinning plant is attached buys and sells more or less yarn. If the yarn spun in the mill is treated as if it were purchased the estimates of the cost of individual fabrics will be more uniform

and better suited for comparison than if an attempt is made to estimate the cost of each worsted department for each fabric when made of home yarn, while necessarily omitting such details when the yarn is purchased and the first cost includes the cost of manufacturing the yarn.

In other words, the manufacture of worsted yarn in a mill where the yarn is woven into cloth should be

Cost Statement Darius Yarn Mill
11 months ending Sept. 30, 2730 working hours
12 sets 40" Cards 4000 spindles.

Department	Production	Labor		Expense		Average Labor	Average Expense
Sorting	698,058 lbs. gr.	3373	28	2	80	.0048 lb.	
Scouring	330,680 lbs. scd.	496	02	198	40	.0015 lb.	.0006 lb.
Dyeing	128,473 lbs. scd.	2312	51	5781	28	.018 lb.	.045 lb.
Picking	495,990 lbs.	6084	68	2504	92	.0053 Rm.	.0021 Rm.
Carding	1,152,946 Rms						
Spinning	1,152,946 Rms	8967	01	289	92	.0052 Rm.	.00025 Rm.
Fixed	1,152,946 Rms	6458	50	9223	57	.0056 Rm.	.008 Rm.
		24,690	00	18000	89	.0214 Rm.	.0156 Rm.

FIG. 8. RECORD OF PRODUCTION AND COST IN A WOOLEN YARN MILL

treated as an entirely distinct part of the business. If this is done a separate system of production and cost records should be kept for the worsted yarn department, but based on the same general principles as for the remainder of the mill. This method is illustrated by the accompanying report, Fig. 4, of the production and cost of the worsted yarn department of the Chantilly Worsted Mills, for which the report covering all the operations has already been shown.

The production of the spinning frames in hanks of

560 yards is taken as a basis for calculating the fixed charges. This unit, the hank, is the standard of production for worsted yarn, as the yard of 50 picks per inch is the standard for cloth.

Cost of Manufacturing Woolen Yarn

When woolen yarn is spun and woven into cloth in the same mill one estimate of cost covers all the processes from raw stock to finished goods, without separating the cost of the yarn, as in the case of worsted. In a spinning mill making woolen yarn only, it becomes necessary to estimate the cost of the yarn, the method being based on the principles already explained. The cost of the raw material is calculated from the cost of the picked stock per pound and the shrinkage in carding, spinning and twisting. The cost of manufacturing is found by calculating the quantity of material that must be passed through each process to make a given quantity of yarn, say 1,000 lbs., and by extending these quantities at the respective cost averages obtained from the production and cost records of the mill.

The production of the mules in runs of 1,600 yards is taken as a basis for apportioning the cost of the fixed charges. This unit, the run, is the standard of production for woolen yarn, as the yard of 50 picks per inch is for cloth, and the hank of 560 yards is for worsted yarn.

As the method of calculating the cost of yarn is based on the same principles as those already explained in estimating the cost of cloth, we will, instead of repeating that explanation here, give a few examples in estimating the cost of carded woolen yarn.

Fig. 8 is the production and cost statement of a woolen yarn mill running on yarns varying from 3 to 6 runs. This statement is similar to those at Figs. 1, 2, 3, and 4, showing the production and cost at each process and the amount of the fixed charges. The cost averages are based on the respective production units, that for the fixed charges being the run of 1,600 yards.

Cost of 5-Run Warp Wool Dyed

Stock: 30% Fine × .38 } .954
70% Wool 1.20 }

18% Loss = $1.163 per lb. Yarn.

Manufacturing 1000 lbs. yarn					
Sorting	2438 lbs.	.0048		11.70	
Scouring	8538 lbs.	.0015	.0006	1.28	.51
Dyeing	12194 lbs.	.018	.045	21.94	54.85
Carding	5000 Rs.	.0053	.0021	26.50	10.50
Spinning	5000 Rs.	.0052	.00025	26.	1.25
Fixed	5000 Rs.	.0056	.008	28.	40.
				115.42	107.11

Cost per lb. Yarn

Stock	1.163
Labor	.115
Expense	.107
No. 86	1.385

FIG. 9. ESTIMATED COST OF WOOLEN YARN

Having compiled this production and cost record of the mill, calculating the cost of any particular size or kind of yarn made in the mill becomes an easy matter.

Fig. 9 is an estimate of a 5-run wool-dyed yarn. First comes the stock mixture and price per pound. From this and the shrinkage, 18 per cent., in weight, the cost of raw stock per pound of yarn is found to be $1.163.

Next comes the cost of manufacturing. The quantity of material that must be run through each process in order to produce 1,000 lbs. of yarn is calculated and extended at the respective cost averages for labor and

Cost of 3½-Run Warp Grey
Stock 55% Fine × .38 } .749
45% wool 1.20 }
22% Loss = $.947 per lb. yarn

Manufacturing	1000 lbs. yarn			
Sorting	1648 lbs. .0048		7.91	
Scouring	577 lbs. .0015	.0006	.87	.35
Carding	3500 lbs. .0053	.0021	18.55	7.35
Spinning	3500 lbs. .0052	.00025	18.20	.88
Finish	3500 lbs. .0056	.008	19.60	28.
			65.13	36.58

Cost per lb. yarn
Stock .947
Labor .065
Expense .037
No. 87 1.049

FIG. 10. ESTIMATED COST OF WOOLEN YARN

expense as taken from the production and cost statement of the mill, Fig. 8. The totals of these items show the cost of manufacturing 1,000 lbs. of yarn, the

cost per pound being found by moving the decimal point three places to the left. The cost of stock, labor and expense are then combined to give the mill cost $1.385 per pound of yarn.

Fig. 10 is an estimate of the cost of a 3 1/2-run gray yarn made in the same mill. A comparison of this estimate with that at Fig. 9 for a dyed yarn shows very clearly not only the difference in the cost of the two yarns, but also the reasons for the difference. The lower cost of the raw stock, the smaller quantity of wool sorted and scoured, the omission of the dyeing process and the reduced number of runs required for 1,000 lbs. of yarn combine to lower materially the cost of the 3 1/2-run yarn below that of the 5-run yarn.

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